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"HISTORY OF THE MK 28 WEAPON

SC-M-67-665

Redacted Version

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Information Research Division, 3434

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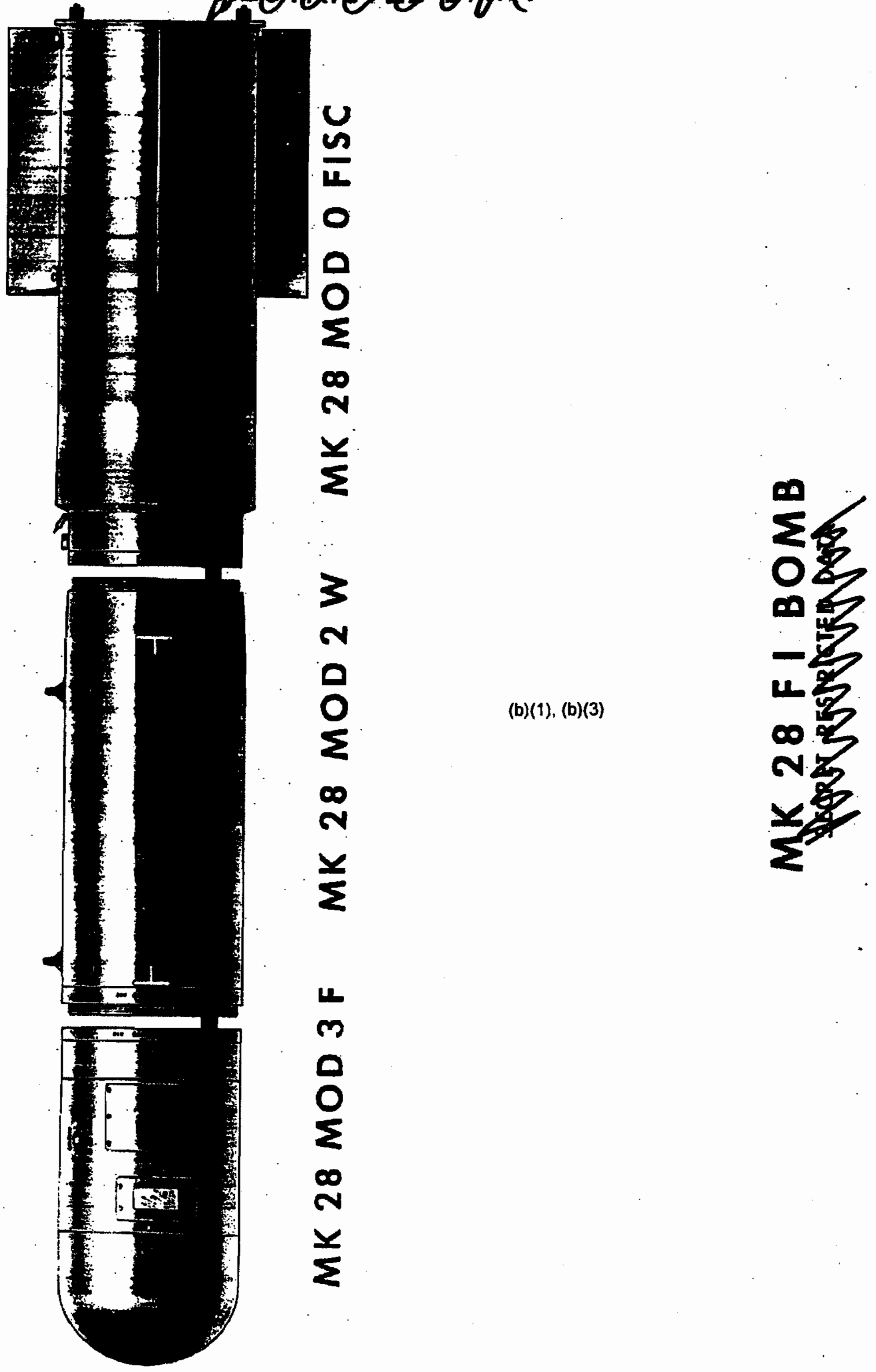

(b)(1), (b)(3)

Mk 28 FI Bomb - External View

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Timetable of Mk 28 Events

Mk 28 EX and IN Bombs

2/5/54

8/5/54

(b)(3)

11/4/54

11/7/54 TX-Theta Committee proposes design of XW-27 and XW-28.

3/24/55

(b)(3)

Spring 1955 (b)(1), (b)(3) Boosting techniques tested.

5/27/55 Sandia outlines design of a proposed TX-28 Bomb to the Division of Military Application.

6/29/55

(b)(3)

10/26/55 Proposed ordnance characteristics of TX-28 presented to Special Weapons Development Board.

(b)(1), (b)(3)

6/57 Mk 28 EX Mod 0 and Mk 28 IN Mod 0 Bombs design released.

8/21/57 Status at design release reported to Special Weapons Development Board.

8/58 Early production of Mk 28 EX and IN Bombs.

3/59 Final evaluation of Mk 28 EX and IN Bombs releasei.

Mk 28 RE Bomb

8/5/55	Possibility of creating a ruggedized Mk 28 Bomb discussed by TX-Theta Committee.
10/26/55	Test results of retardation devices presented to meeting of Special Weapons Development Board.
4/56	Proposal for retarded trajectory version of Mk 28 Bomb presented to Tableleg Committee.
8/3/56	Air Force Special Weapons Center advocates work on drogue parachute-retarded Mk 28 Bomb.
1/17/57	Division of Military Application released production authorization for drogue-retarded Mk 28.
4/58	Mk 28 RE Bomb design released.
8/20/58	Status-at-design-release report presented to meeting of Special Weapons Development Board.
3/59	Early production of Mk 28 RE Bomb achieved.
11/59	Final evaluation of report of Mk 28 Mod 1 Bomb released.

Mk 28 RI Bomb

3/58	Strategic Air Command notes that high-altitude target approaches will be abandoned in favor of low-altitude approaches.
4/17/58	Assistant Secretary of Defense requests United States Atomic Energy Commission to develop a maximum-drogued Mk 28 Bomb.
4/59	TX-28-X2 design released.
10/21/59	Report on status at design release presented to meeting of Special Weapons Development Board.
6/60	Mk 28 RI production achieved.

Mk 28 FI Bomb

6/30/59	Sandia proposes design of a full-fuzing-option Mk 28 Bomb, with laydown capability.
8/18/60	Operational requirement for TX-28-X3 released.

10/12/61	Proposed ordnance characteristics of TX-28-X3 accepted by Field Command.
7/62	Early production of Mk 28 FI achieved.
5/63	Final development report of Mk 28 FI Bomb released.

Mk 28 Warhead

6/57	Mk 28 Mod 0 Warhead design released.
8/58	Early production of Mk 28 Mod 0 Warhead achieved.
5/60	Early production of Mk 28 Mod 1 Warhead achieved.
1/62	Early production of Mk 28 Mod 2 Warhead achieved.
12/62	Early production of Mk 28 Mod 3 Warhead achieved.
7/63	Early production of Mk 28 Mod 4 Warhead achieved.

Mk 28/MACE Warhead Installation

1/18/56	Production authorization released for Mk 28/MATADOR. Missile later redesignated MACE.
3/14/56	Military characteristics for Mk 28/MACE approved by Military Liaison Committee.
6/59	Mk 28 Mod 0 Warhead released for use in the MACE missile.
8/62	Final evaluation report of MACE Warhead Application released.

Mk 28/HOUND DOG Warhead Installation

1/58	Feasibility study of warhead installation for HOUND DOG missile requested.
5/16/58	Assistant Secretary of Defense selects XW-28 Warhead for installation in HOUND DOG missile.
5/28/60	Initial authorization for restricted use of Mk 28/HOUND DOG issued.
12/61	General release of Mk 28/HOUND DOG authorized.
3/62	Final evaluation of Mk 28 Mod 1 Warhead in HOUND DOG missile released.

The missile warhead weight would be a minimum and not exceed 2800 pounds. The warhead would be compatible with the Air Force MATADOR, RASCAL, SNARK and NAVAHO; the Navy REGULUS and TRITON; and the Army REDSTONE. Manually and electrically operated arming and safing components would be incorporated, as well as a device to monitor the safe or armed condition of the warhead.

(b)(1), (b)(3)

The TX-Theta Committee, meeting September 17, 1954, reported that the weight and diameter of externally carried bombs had a significant effect on the range and speed of carrying aircraft.

(b)(3)

The TX-Theta Committee again met November 5, 1954.

(b)(1), (b)(3)

The TX-Theta Committee wrote to Santa Fe Operations Office, November 17, 1954, proposing that two different weapons be built, a large-diameter XW-27 Warhead compatible with missile carriers and a smaller diameter TX-28 Bomb to be externally and internally carried on high performance fighter bombers.

(b)(1), (b)(3)

It was hoped that suitable weapon designs could be released by early 1957, with production occurring in the mid-part of that year.[5]

Sandia discussed the design of the TX-28 in the December 1, 1954 meeting of the Special Weapons Development Board. The maximum length of the bomb was felt to be 250 inches, although shorter lengths suitable for internal carriage

(b)(1), (b)(3)

It was hoped that a bomb considerably smaller in diameter and weighing less than 2800 pounds could be developed and, if necessary, some reduction in yield would be acceptable. The Military Liaison Committee requested that a diameter of about 25 inches be considered, and this study was assigned high priority.[8]

(b)(1), (b)(3)

(b)(1), (b)(3)

Also, due to radioactive decay, the amount of tritium in the gas decreased steadily and had to be periodically replaced. This replacement could be most conveniently done if the boosting gas was in a replaceable reservoir.

(b)(3)

By April 1955, Sandia was designing the TX-28 fuze. Barometric fuzing had been considered, but rejected due to the wide variety of delivery systems and consequent variation in delivery velocities. This variation made it difficult to develop a satisfactory pressure-sensing system, and the use of different field settings for each mission would have negated a ready-weapon concept. A timer was considered, and would have allowed a slightly better minimum release angle in LABS (Low-Altitude Bombing System) missions and a

Details of the TX-28 design then became firm. The weapon center section would be a partially contoured cylindrical case, 20 inches in diameter and 49 inches long, and capped at each end with a hemisphere.

(b)(1), (b)(3)

One fin could be folded, to provide ground and aircraft carriage clearance. The fin control mechanism would be powered by explosive squibs, actuated at bomb release from the carrying aircraft. The feasibility of the 3-hook suspension was felt to be doubtful, in view of possible warhead requirements, and this design was dropped.[18]

The design of the TX-28 Prime fuze was also proceeding rapidly. One-shot, explosively actuated switches would control such actions as preheat current switching, timer output selection, high-voltage thermal-battery arming, ground- or air-burst selection, contact-fuze arming, timer-motor starting, trajectory-arm-switch pressure-port sealing, gas-boost initiation, and even thermal-battery monitoring. These switches were small, light, resistant to shock, and could be used extensively.[19]

Operational safety would be increased by the installation of a switch which would close after experiencing the normal trajectory of a free-fall bomb. This switch was a dual-chamber baroswitch. One chamber was sealed when the bomb was released from the aircraft, and the second measured the pressure increase as the bomb fell toward its target.

(b)(1), (b)(3)

Choice of air burst or contact option would be made before takeoff, and the operations required of the pilot prior to release of the weapon were reduced to 3, as compared to about 15 required for other tactical fuzes. Basic design emphasis was placed on simplification, miniaturization and operational safety.

The length of the bomb was 170 inches, thus resulting in a fineness ratio of 8.5, and the weight was estimated to be 1700 pounds. The bomb was divided into three parts: Nose (containing fuze), center section (containing primary and secondary), and tail. The weapon could be shortened for internal carriage (b)(3)

Report SC3691(TR), Proposed Ordnance Characteristics of the TX-28 Atomic Weapon, was presented to the October 26, 1955 meeting of the Special Weapons Development Board.[22] This report noted that the tail could be rotated in increments, thus allowing the fin to fold either up or down. A fuze access panel was provided, to allow access to the high-voltage thermal cells.

A pulse pullout plug fired squib switches when the bomb was released from the carrying aircraft. The case of this plug failed at a break line, and the two sections of the plug separated. The safety ground was broken during the motion of the plug and a pulse of 28-volt aircraft power applied to the squib lines. The safe-separation timer was dual-channeled for reliability. Both long and short times were available, and both times could be set in each channel.[23]

(b)(1), (b)(3)

Santa Fe Operations Office accepted these yield designations, but requested

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identify the internal-carriage version.[27] Sandia noted that omission of yield or configuration designation would mean broad applicability to all yields or configurations.[28]

(b)(1), (b)(3)

The Mk 28 EX Mod 0 and Mk 28 IN Mod 0 were design released June 1957, and early production achieved in August 1958. Sandia presented Report SC4092(TR), interval timer, 28 volts was applied to the squib transformers of the high-voltage thermal-battery pack. This activated the batteries and initiated charging of the X-unit capacitor bank. The firing circuits of the radar sets were also armed at this time.

When the bomb fell to an altitude above the target equal to the range setting in the radar system, a firing relay in the radars connected 28 volts to the weapon firing circuit and triggered the spark gap. The 2500-volt output of the X-unit then discharged through the gap, firing the weapon detonators.

If the radar system failed, ground impact operated the contact crystals unless contact preclusion had been selected before aircraft takeoff. Operation of the contact crystals produced a voltage which triggered the thyratron in the weapon trigger circuit. A capacitor then discharged through a pulse transformer in the weapon firing circuit and triggered the spark gap.

Contact option was made by selecting the Ground option on the aircraft monitor and control system. This action operated the electrical safing switches in the weapon. At bomb release, thermal batteries were activated, interval timer started, pressure ports of the fixed differential pressure switch sealed, fin extending mechanism actuated (for externally carried bombs only), and the contact option switch which disconnected the radar fire line was operated. The pullout switch closed, applying the 28-volt output of the thermal batteries to the fuzing system.

(b)(1), (b)(3)

At the end of the safe-separation time preset on the interval timer, a switch closed to operate the contact arm switch and start charging the X-unit. At ground impact, the crystal net produced a voltage which triggered a thyratron and subsequently the spark gap. The X-unit output then discharged through the gap, firing the weapon detonators.[31]

use of shock-mitigating materials. It was felt possible to design a bomb to withstand laydown impact shocks of 200 to 300 g's.[33]

Design progress was discussed in the October 26, 1955 meeting of the Special Weapons Development Board. Sandia stated that both parachutes and rotochutes had been tested. Existing parachute designs were not able to absorb the shock created by a bomb released at high speeds, and a stronger parachute was being designed. Rotochutes could not properly handle the bomb weight. Retrorockets had been considered, but these imposed operational restrictions.

Sandia had recorded promising shock-cushioning tests of honeycomb material in drops from 14- and 80-foot towers, and was erecting a 300-foot tower, which would produce vertical impact velocities of about 135 feet per second, about that of a parachute-retarded bomb. Devices to be tested would be guided by a slanting cable which would allow application of side forces, such as those caused by wind effects or tumbling of the weapon after target impact.[22]

Early in 1956, Sandia analyzed the delivery characteristics of several low-level, retarded-delivery systems. The study concluded that a retarded trajectory version of a nonimpact-resistant TX-28 type weapon was desirable, and that this device could be produced well before the true laydown weapons then under development. The study results were subsequently presented to the Tableleg Committee (investigating the laydown design) in April 1956 as an interim method of achieving many of the laydown weapon objectives about 2 years in advance of the true laydown weapon.[34]

Results of the study were incorporated in Report SC3860(TR), *Design Study of a Drogue-Retarded TX-28 Weapon Family.* The study proposed finless external and internal retarded versions of the TX-28 free-fall bombs, but without the capability of inflight selection of retarded or free-fall delivery.[34]

After presentation to the Air Force of proposals for retardation of TX-28 weapons, the Air Force requested the capability of inflight selection of retarded or free-fall delivery. Preliminary investigation showed that this could be accomplished by using a small pilot parachute for stabilization in the free-fall mode and by using the pilot chute to deploy a large drogue parachute for the retarded mode. Selection of delivery option would be accomplished by minor modification of the aircraft monitor and control system.[35]

The Air Force Special Weapons Center wrote to Field Command August 3, 1956, advocating the drogue parachute program, as this would increase bomb-delivery accuracy. The existing bomb tail would not be large enough to hold the drogue parachute, and a new tail would have to be provided. This increase in size would aggravate ground and aircraft clearance problems, and might make it impossible to allow room for stabilizing fins. Thus, a decision to use this type of delivery might have to be made before final bomb assembly.[36]

The Division of Military Application was notified September 26, 1956 that a drogue-retarded TX-28 weapon family would not delay or compromise the rest of the project. The weapon system would be a little complex, due to the number of different units required to make the TX-28 a universal-use weapon. However, it was felt that production and stockpiling problems would not be too formidable.[37,38]

Production authorization for the drogue-retarded Mk 28 was issued January 17, 1957 by the Division of Military Application.[39] The design was named the TX-28-X1, and a stockpile date of June 1958 was requested.[40] The tail would incorporate two parachutes; a small, stabilizing chute for free-fall deliveries and a larger chute for retarded deliveries. When the large chute was used, the section containing the small chute would be jettisoned.[41]

The design would have the capability of inflight selection of retarded or free-fall option in a single, streamlined shape suitable for external carriage by the designated aircraft and for internal carriage by the A3D, and no changes to the aircraft monitor and control system would be required. No requirement was established for an internally carried retarded TX-28 as it was felt that this would unacceptably complicate weapon design, stockpiling and logistics.[42]

If the radar system failed, impact with the ground operated the contact crystals unless contact preclusion had been selected before takeoff. Operation of these crystals produced a voltage that triggered a thyratron, discharging a capacitor through the spark gap, and firing the X-unit and detonators.

In the contact option, preflight setting of the option plug to the contact backup position was made. The contact option was then chosen in flight by turning to the Ground position on the aircraft monitor and control. At bomb release, arming was accomplished in the same manner as for the air-burst option, and aircraft power through the pulse plug fired an option switch which disconnected the radar fire lines from the weapon firing circuit. At the end of safe-separation time, a squib switch in the trigger circuit was actuated, closing the line between a thyratron tube and the gap firing transformer, thus arming the contact system. At surface impact, the crystal network produced a voltage that detonated the bomb.

Contact bursts could be precluded by preflight setting of the option plug to the contact-preclude position. The arming and firing sequence was the same as for the air-burst option with contact backup, except that the contact system was never armed.[35]

Report SC4150(TR), Description and Status at Complete Design Release of the TX-28-X1 Bomb, was presented to the August 20, 1958 meeting of the Special Weapons Development Board.[46] The Mk 28 EX Mod 1 was 160 inches long, weighed 2020 pounds, and provided external carriage and free-fall delivery. The Mk 28 IN Mod 1 was 96.4 inches long, weighed 1940 pounds, and provided internal carriage and free-fall delivery. The Mk 28 RE Mod 1 was 166 inches long, weighed 2140 pounds, and provided retarded delivery.

(b)(1), (b)(3)

The radar was capable of reliable operation at all weapon attitude angles up to and including 60 degrees from the vertical. For larger angles, the system reliability was lowered. There were two fuzing limitations. A 10-second timer setting was the minimum available for safe separation, and (b)(3) Firing was then accomplished, either by radars ranging for air-burst or by impact fuzes at time of contact.[47]

Mk 28 Retarded Internal (RI) Bomb

In late March 1958, the Strategic Air Command noted that enemy defenses had increased to the point where all high-altitude target bombing approaches were being abandoned in favor of an "on-the-deck" approach. It was pointed out that no thermonuclear bomb currently available could be released at altitudes of 1500 feet or less, and it was requested that the Mk 28 be modified to allow it to be so released. The carrying aircraft would be the B-47, and some degradation in ballistic performance would be acceptable, if an immediate capability could be provided.[48]

Subsequently, April 17, 1958, the Assistant Secretary of Defense requested the Atomic Energy Commission to develop a maximum-drogued Mk 28 Bomb. This design would require a new afterbody, parachute and fuze, and would be supplied in the form of a conversion kit that could be applied to any stockpiled Mk 28. This TX-28-X2 design would have a 40-second down-time from a release altitude of 1500 feet. The weapon would be fuzed for contact burst only, and would be capable of being carried in the B-47, B-52 and possibly the B-66.[49]

Design work was immediately started.[50] Initial verbal requirements were for a "fail-safe" system in which the weapon would not arm and fire in the event of parachute failure. However, on the basis of informal guidance, a "fail-arm" system, which would arm and fire regardless of proper parachute operation, was considered and specified in early August 1958. No external power would be required, except for a prerelease arming signal. At release, a pulse of power from a generator would initiate fast-rise thermal batteries that would subsequently furnish all the bomb power requirements.[51]

The design required that the pullout cables be located in the bomb tail and the fuze in the bomb nose, and external fairings were installed to connect these two sections and provide room for interconnecting cabling. The bomb was armed or safed by the aircraft monitor and control system, with high-voltage safing being accomplished by a motor-driven switch, and low-voltage safing by a manually operated control. A check of the safe or ready condition of the weapon could be made by a hand-cranked continuity tester whose output current was less than that required to fire any bomb component.

The initial approach to the design of the fail-arm fuze was to provide automatic selection of arming time compatible with proper parachute operation.

(b)(3)

Since the retarded time of fall was 50 seconds, the thermal batteries required comparatively long life. No existing battery was suitable, and work was started on a new design. As information on the deceleration signature of the parachute deployment system would not be available until late in the program, it was decided to provide an alternate system. In this design, closing of a trajectory arm switch fired an explosive device that locked-in the arming power. The closure of this device completed the circuit from the low-voltage thermal battery to the arming components, and thus a highly reliable design was needed. This was furnished by an existing switch activated by either of two squibs and having a fusible disc that would melt in a fire and disconnect the switch from the weapon system. The Military subsequently requested that the bomb system be designed to fail-safe, to assure safe-separation time for carrier aircraft, and a safe-separation timer was added.[52]

Initially, it had been planned to install removable safing pins in the pulse-generator pull rods, and the Air Force was to provide a manual system to remove these pins after the weapon was airborne. This was found to be impractical, and the system was changed to include a motor-operated arm/safe switch, which completed the circuit between the pulse generator and the low-voltage thermal battery. This change permitted the bomb to be dropped in a safe condition without initiating the power supplies.

The TX-28-X2 was design released in April 1959 and Report SC4253(TR), Status at Complete Design Release of the TX-28-X2 Bomb, was presented to the October 21, 1959 meeting of the Special Weapons Development Board.[53] The forward section of the bomb was 20 inches in diameter and the tail section was 22 inches in diameter. The bomb was 132 inches long, weighed 2265 pounds and could be internally carried in B-47 and B-52 bombers.

(b)(3)

The Mk 28 Retarded Internal Bomb achieved production in June 1960. The design consisted of the Mk 28 Mod 1 Warhead, Mk 28 Mod 2 Fuze, and Mk 28 Mod 0 Retarded Internal Shape Components.

Before loading the weapon in the delivery aircraft, the safe condition of the system was checked with a built-in continuity monitor and a safe-separation timer was set. After loading, the aircraft monitor and control power was turned on with the option select switch in Safe position. This released a solenoid interlock on the Ready/Safe switch, which was then turned to Ready.

In flight, and preferably after entering enemy territory, ground burst was selected on the aircraft control. When this was done, two arming/safing switches operated to the Arm Position. One of these switches connected the pulse-generator output to the initiating circuits of the low-voltage thermal-battery pack, and the other connected the high-voltage battery to the X-unit capacitor bank. If air burst was inadvertently selected, the system would function in the same way and automatically selected ground burst.

At bomb release, pullout rods actuated pulse generators. Output pulses from these generators initiated low-voltage thermal batteries and started deployment timers. As the bomb entered the airstream, differential pressure across the aerodynamic fences caused a pressure switch to close, connecting the 1-second contacts in the deployment timers to the activation circuits of the detonators, safe-separation timer, and switch pack. At the end of 1 second, timer contacts closed, connecting the 12-volt sections of the low-voltage thermal batteries to the components noted.

The detonators fired and initiated a length of mild detonating fuse which blew off the rear cover plate. As the cover plate fell away, it deployed the pilot parachute, which in turn deployed the first-stage chute. Explosive motors in the safe-separation timer fired and unlatched the starting mechanism, which allowed the timer to begin timing. The switch pack operated and connected the 28-volt sections of the low-voltage batteries to the safe-separation timer contacts, trigger-circuit option switch, and explosive motors in the reservoir and valve assembly.

(b)(3)

The actuators fired, causing the bolt to fracture. The lug release ring separated from the lug mounting plate. The lugs pivoted, releasing risers of the first-stage parachute. As the first-stage chute fell away, it deployed the second-stage chute.

At the end of safe-separation time, contacts of the safe-separation timer closed and connected the 28-volt output of the low-voltage batteries to the primaries of the high-voltage-battery actuating transformers. The high-voltage thermal batteries activated and charged the X-unit capacitor bank.

Since existing radars would require more space than could be provided, and a smaller unit, being designed, would not be immediately available, a timer fuze was proposed. This was rejected, after study, as it involved possible errors in release altitude and variations in the time of fall. A baroswitch with a fixed burst altitude was then considered, and felt to be acceptable.

A remotely settable baroswitch was required, in order to permit the Strategic Air Command to control the fixed setting at depot level with available equipment. To eliminate the need for preflight selection of retarded or free-fall delivery mode, a system was proposed in which the release altitude was sensed and used to select the mode automatically. If the release was made at high altitudes, the weapon would drop free fall; with a low-altitude release, a retardation system would be used. The two altitude ranges were separated by a region in which weapon releases were not anticipated. For free-fall drops, the aircraft would be at or near its maximum altitude and, for retarded drops, the altitude would be only a few thousand feet above sea level. Several available switches could be used. The firing signal would be supplied by a timer in the laydown option and by contact crystals for surface detonation.

An operational requirement for the TX-28-X3 was issued by the Deputy Director for Research and Engineering August 18, 1960, and early production requested in February 1962. The design would be capable of being released 500 feet above the target, be carried internally in the B-47 and B-52 aircraft, and have a full-fuzing option.[58]

The bomb nose was provided with 8 inches of crushable honeycomb to absorb laydown shocks. A fourth parachute was added to the Mk 28 Retarded Internal Bomb design to provide free-fall stabilization and reduce baro sensing errors, and the design was released October 1961.

Report SC4534(WD), Proposed Ordnance Characteristics of the TX-28-X3 Bomb, was accepted by Field Command October 12, 1961. The Mk 28 FI Bomb consisted of a Mk 28 Mod 2 Warhead, Mk 28 Mod 3 Fuze, and Mk 28 Mod 0 Full-Fuzing

Since retarded laydown was desired, the release altitude must be below 12,000 feet pressure altitude, assuring that the baroswitch was closed at release. Laydown was achieved by releasing the weapon at an altitude no lower than 500 feet above the terrain and no higher than 2400 feet, to allow the bomb to reach the ground before the end of the 79-second interval.

At release, the pullout generator was actuated to initiate the low-voltage thermal batteries and start the sequential timer. As the 12-volt sections of the low-voltage batteries came up to voltage (a maximum of 0.7 second after initiation), the differential pressure inducers and the baro ports operated. If the release velocity was greater than the required minimum, the differential pressure induced across the pressure inducers caused the pressure switches to close and connected a set of timer contacts to the activation circuits of the fuse switches. About 0.7 second after pullout-generator actuation, the timer contacts closed and connected the 12-volt sections of the low-voltage thermal batteries to a set of switches and a 60-second pyrotechnic timer, through the closed contacts of the pressure switches and the baroswitch, and to two of the six detonators. These detonators initiated mild detonating fuse which removed the rear cover plate from the bomb. As the cover plate blew off, the 4-foot pilot parachute deployed a 16-1/2-foot-diameter parachute. The 12-volt sections of the low-voltage batteries were meanwhile connected to the contacts of the timer and to the neutron generators.

Approximately 2.4 seconds after pullout generator actuation, a second set of timer contacts closed and connected the 12-volt sections of the low-voltage thermal batteries to a second pair of detonators. These ignited a length of mild detonating fuse which initiated deployment of the second-stage chute. The time of fall from 500 feet above the target altitude was about 10 seconds.

(b)(3)

initiated, but those in the parachute jettison device were activated. The 4-foot pilot chute deployed the 16-1/2-foot chute, and both the 16-1/2- and 64-foot chutes were then jettisoned, and a 30-inch drag chute deployed by action of the jettison device. At the time the chutes were jettisoned, switches were activated, connecting the first set of contacts of the timer to the fuzing circuit. At closure of this timer, explosive switches in the switch pack and the option switches were operated.

(b)(3)

Upon reaching the burst altitude, the baroswitch closed, applying a firing signal to the trigger circuit. If the air-burst option failed, the bomb was detonated at impact by a signal from the impact crystals.

In the free-fall contact option, the fuzing and firing system operated as in the free-fall air-burst option, with some exceptions. Before release, the aircraft monitor and control was placed to the Ground position. This action completed all circuits as in the free-fall air-burst option, except that the firing baro was not connected into the fuzing circuits. At impact, a fire signal was supplied by the impact crystals.[60]

Mk 28 Warhead

(b)(1), (b)(3)

The warhead design was released in June 1957 and achieved early production in August 1958. The Mod 0 Warhead contained an internal initiator.

The Mod 1 Warhead was equipped with external initiation and the first production date was May 1960. The Mod 2 Warhead was strengthened against laydown usage, and the design was first produced in January 1962.[61] The Mod 3 Warhead contained Category A permissive arming links and was first made in

62

Ground compatibility tests of warhead with missile were begun in April 1959 and satisfactorily completed in July 1959. Flight tests were conducted between late 1959 and early 1961. Restricted use of the Mk 28 Mod 0 Warhead in the HOUND DOG was authorized May 28, 1960, and a general release was issued December 1961.

Report SC4572(WD), Final Engineering Evaluation Report of GAM-77 (HOUND DOG) Application of the Mk 28 Mod 1 Warhead, was dated March 1962. The missile was a turbojet-powered, air-to-ground strategic missile designed for launch from B-52 aircraft. Each airplane could carry two missiles. The missile was of mid-wing canard configuration and had an underslung pod for the jet engine. It had a major fuselage diameter of 28.5 inches, length of 42.5 feet, and major wingspan of 12.3 feet. The missile maximum velocity was Mach 2.1 and its range 650 nautical miles.

Development responsibility for the arming and fuzing system was assigned to North American Aviation. The warhead itself was 20 inches in diameter, 60 inches long, and weighed 1645 pounds with internal initiator and 1675 pounds with external initiator.

The missile had five basic delivery profiles. The high-altitude missile cruise mode could be initiated from either high or low altitude. The same option was available for the low-level cruise mode. A free-fall bomb-drop capability provided an emergency delivery option in the event of missile system malfunction.

The first three steps in the arming and fuzing sequence were independent of missile flight mode. Prior to launch, aircraft power was switched to the safing-switch motors which drove the switches to the Arm position. At launch, pullout-switch closure applied either normal missile power or emergency battery power to the safe-separation timer. The duration of timer operation was dependent on prelaunch setting. At the end of safe-separation interval, timer contacts closed and applied power to either the arming and fuzing baroswitches or the autonavigator. For high-altitude cruise and free-fall modes,

(b)(1), (b)(3)

Department of Defense -- The Armed Forces; i.e., the Army, Navy and Air Force.

Detonator -- Explosive device which, when initiated by the X-unit, ignites the lens charges of the high-explosive sphere.

Deuterium -- The hydrogen isotope of mass number 2.

(b)(1), (b)(3)

Joint Chiefs of Staff -- A group composed of the Chiefs of Staff of the Army, Navy and Air Force to determine policy and develop joint strategic objectives of the Armed Forces.

Kilogram -- A metric weight approximately 2.2 pounds.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

(b)(1), (b)(3)

Mach -- A measure of speed. Mach 1.0 is the speed of sound, or 738 miles per hour at sea level.

Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

Nautical Mile -- A naval measurement of length. One nautical mile is equivalent to 6076.1033 feet, or the length of 1 minute of arc (1/21,600) of a great circle of the earth.

Neutron -- An uncharged particle of slightly greater mass than the proton.

Operation Castle -- See Castle.

Operation Greenhouse -- See Greenhouse.

Operation Redwing -- See Redwing.

Operation Teapot -- See Teapot.

Permissive Arming Link -- A device designed to delay or prevent unauthorized personnel from being able to arm and detonate a weapon full scale.

Pit -- The metal sphere at the center of an implosion bomb which received the nuclear capsule when it is inserted.

Plutonium-239 -- A radioactive heavy element, atomic number 94.

Primary -- A fission bomb that acts as the source of energy to start the secondary of thermonuclear reaction of a two-stage device.

Proton -- The nucleus of the atom of the light isotope of hydrogen. It has a unit positive charge of electricity.

Radar -- Named for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

Redwing -- A full-scale nuclear series of 17 tests held at the Pacific Proving Grounds from May 4 to July 21, 1956.

Reservoir -- A container for deuterium-tritium boosting gas.

Ribbon Parachute -- A parachute having a set of ribbons in place of a solid canopy. This type of parachute provides less severe deceleration on deployment.

Rotochute -- A device to slow down the rate of descent of a free-fall weapon. Consists of counterrotating propeller blades which absorb energy.

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__Tactical__ -- Use of a weapon against troops or concentrations of war materiel.

__Teapot__ -- A less-than-full-scale test series held at the Nevada Test Site. Series of 14 tests, starting February 18 and ending May 15, 1955.

__Thermal Battery__ -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to this electrolyte, melting it and putting the battery into active output condition.

__Thermonuclear__ -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

__Thyratron__ -- A grid-controlled electron tube.

__Tritium__ -- The hydrogen isotope of mass number 3.

__Two-Stage__ -- Combination of fission and fusion action in a weapon.

TX-Theta Committee -- A committee established to guide the development of thermonuclear weapons.

Uranium-235 -- A radioactive element, an isotope of uranium-238.

Uranium-238 -- A radioactive element, atomic number 92. Natural uranium contains about 99.3-percent uranium-238; the rest is uranium-235.

X-Unit -- A device used to provide high voltage to the weapon detonators.

Yield -- The measure of the effect of a nuclear detonation compared to the effect of an explosion of TNT.

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